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AB The title steel contains **C** ≤0.2, **Si** ≤1.0, **Mn** ≤2.0, **Cr** 20-27, **Ni**+**Co** 17-27, Mo+1/2W 2-7, N 0.01-0.3, Cu 0.1-3% and **Fe** as the balance in satisfaction with the following relation: **Cr**+**Ni**+**Co**+2Cu+4.1(Mo+1/2W)+24N ≥62. Optionally, the steel also contains ≥1 metals of Zr ≤0.5, **B** ≤0.01, Ca ≤0.02, **Al** ≤0.1, La ≤0.04, Ce ≤0.04, Y ≤0.1, **Ti** ≤0.5, **Nb** ≤0.8, Ta ≤1.6, and **V** ≤1.0%. The steel is suitable in treatment of toxic wastes under supercrit. temperature and supercrit. pressure conditions.

≤0.2 C
≤1 Si
≤2 Mn
P
S
17-27(Co+Ni)
Ni
20-27
Co
≤0.5 Ti
≤0.8 Nb
≤1. V
≤0.01 B
≤0.1 Al
0.01-0.3 N
O
2-7 Mo W

PATENT ABSTRACTS OF JAPAN

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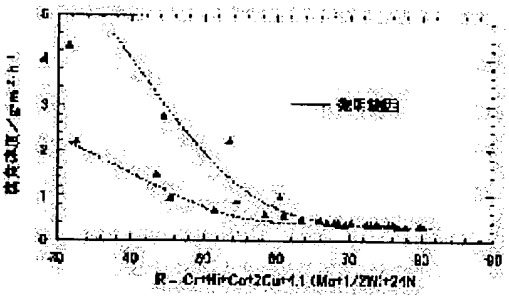
(54) HIGH CORROSION RESISTANT STAINLESS STEEL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a material having excellent corrosion resistance, mechanical properties and economical efficiency to e.g. an oxidative decomposition treatment plant using high-temperature high-pressure fluids.

SOLUTION: The high corrosion resistant stainless steel which has a chemical composition consisting of by mass, ≤0.02% C, ≤1.0% Si, ≤2.0% Mn, 20-27% Cr, 17-27% of (Ni+Co), 2-7% of (Mo+1/2W), 0.01-0.3% N, 0.1-3% Cu and the balance essentially iron and satisfying relation Cr+Ni+Co+2Cu+4.1 (Mo+1/2 W)+24N≥62 is used. Further, either or both of ≤0.01% B and ≤0.5% Zr, one or more kinds among ≤0.02% Ca, ≤0.1% Al, ≤0.04% La, ≤0.04% Ce and ≤0.1% Y, or one or more kinds among ≤0.5% Ti, ≤0.8% Nb, ≤1.6% Ta and ≤1% V can be added.



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CLAIMS

[Claim(s)]
[Claim 1] High anticorrosion stainless steel with which the remainder is iron substantially, and it fills the following formula with it C:0.02% or less including less than [Mn:2.0%], Cr:20-27%, nickel+Co:17-27%, Mo+1/2W:2-7%, N:0.01 - 0.3%, and Cu:0.1-3% below Si:1.0 % when a chemical entity expresses mass% of each element with mass% by each symbol of element.
Cr+nickel+Co+2Cu+4.1(Mo+1/2W)+24N>=62 -- [Claim 2] High anticorrosion stainless steel with which a chemical entity is further characterized by including one or more sorts in less than [Zr:0.5%] B:0.01% or less at mass% in addition to a chemical entity according to claim 1.
[Claim 3] High anticorrosion stainless steel with which a chemical entity is further characterized by including one or more sorts in less than [calcium:0.02%], less than [aluminum:0.1%], less than [La:0.04%], less than [Ce:0.04%], and mass% of inside [Y:0.1% or less of] in addition to a chemical entity according to claim 1 or 2.
[Claim 4] High anticorrosion stainless steel with which a chemical entity is mass% further in addition to claim 1 or a chemical entity according to claim 3, and it is characterized by including one or more of less than [Ti:0.5%], less than [Nb:0.8%], less than [Ta:1.6%], and V:1% or less of sorts.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the equipment ingredient of the elevated-temperature high-pressure fluid use technical relation in the supercritical water, the subcritical hydroxylation plant, etc. which noxious waste can also process.
[0002]
[Description of the Prior Art] While the interest about environmental preservation increases in whole company meeting, a close-up of processing of the toxic material of the difficulty resolvability represented by the chlorinated system organic compound is taken as a future big problem. The oxidation-treatment technique using an elevated-temperature high-pressure fluid is observed as a technique used as the conclusive factor of these decomposition processings these days.
[0003] If the matter exceeds predetermined temperature and flow and pressure requirement, it will be in the supercritical fluid condition with which the liquid and the gas harmonized completely, and the chemical reaction of the matter will be provided with a very activity reaction place also including the subcritical fluid condition of this side. In such a condition, although the application to the waste treatment in supercritical and a subcritical condition is variously tried very much as stability and safe matter and water is used present most widely as a medium of the oxidative degradation of a harmful organic compound, the number of it is one.
[0004] The oxidative degradation method by supercritical water has left the technical problem to the corrosion resistance of an ingredient practical, although the fundamental technique itself is in the situation established mostly. That is, the equipment ingredient itself which touches the chemical reaction place which has very high reactivity has received corrosion damage violently in the present condition.
[0005] Then, nickel radical alloy of high corrosion resistance is mainly used. Moreover, ceramics ingredients, such as a titanic-acid ghost and charcoal and a nitride, a zirconium, and aluminum oxide, are also examined in part from generally corrosion resistance being good.
[0006] In addition, austenitic heat resisting steel has been used for the boiler for which creep strength, a waterproof steamy oxidization property, and high-temperature-corrosion-proof nature are generally needed. An operating environment is making especially a boiler cruel and the austenite heat-resistant alloy is developed for the purpose of sufficient corrosion resistance and the outstanding high temperature strength.
[0007] for example, to JP,6-322488,A By mass %, less than C:0.02%, less than [Si:1.5%] (an example 0.47 - 0.50%), Mn: 0.3-1.5%, P:0.02% or less, S:0.005% or less, Cr: 18-26%, nickel:20-40%, W:0.5 - 10.0%, Nb: 0.05-0.4% (an example 0.18 - 0.23%), Ti:0.01-0.2%, B:0.003 - 0.008% and N:0.05 - 0.3% (an example 0.008 - 0.147%) are contained. Furthermore, the austenite heat-resistant alloy containing two of one sort or Mo:0.5-2.0% and/or Mg:0.001-0.05%, calcium:0.001-0.05%, and rare-earth-elements:0.001-0.15% of sorts or more is proposed if needed.
[0008] In JP,2000-129403,A, C:0.01 - 0.20% (preferably 0.035 - 0.15%), Si: Less than [3.0%] (preferably 0.5 - 2.0%), Mn:0.01-3.0% and nickel:15.0-40.0%, Less than [Ti:0.2%], B:0.006% or less, and N:0.05 - 0.25% (preferably 0.07 - 0.02%) are contained Cr:15.0-30.0%, Mo:0.01-1.0%, W:2.0 - 8.0%, and Nb:0.05-0.8%. The superheater tube for boilers using that W/Mo has 2 or more and 20 - 55% of Fe(s), and the austenite heat-resistant alloy and it which contain one or more sorts of 0.01 - 0.5% of Ta, 0.001 - 0.2% of Zr, and 0.001 - 0.2% of Hf(s) further is proposed.
[0009]
[Problem(s) to be Solved by the Invention] However, there are the following troubles in these ingredients. First,

about nickel radical alloy, when an expensive and large-scale practical use plant is assumed, ingredient cost will become huge and is holding the big technical problem in the balance of cost effectiveness with waste treatment etc. The present condition is that breakage by the thermal shock generally tends to take place, and a ceramics ingredient lacks in practical dependability.

[0010] From a viewpoint of dependability over a thermal shock etc., using the austenitic heat resisting steel for the above-mentioned boilers is also considered. However, these ingredients Since the component design which mainly aimed at the endurance to a high-temperature-corrosion environment is made, in the oxidation and corrosive environment to which supercritical water and subcritical water change, it has a problem in the corrosion resistance in the conditions on which wet corrosion mainly governs corrosion. That is, the consideration to the optimization of element addition, such as Cu and Mo, a technique given in JP,6-322488,A and whose technique given in JP,2000-129403,A can improve the corrosion resistance over wet corrosion is not made enough, or is not added at all. That is, it is a problem from a viewpoint of the general corrosion in a wet corrosion region.

[0011] the high dependability to the corrosion resistance and the mechanical property which were excellent as an equipment ingredient in the oxidative degradation processing plant of the noxious waste which this invention solved the above-mentioned technical problem, and used the elevated-temperature high-pressure fluid etc. -- having -- in addition -- and it aims at offering the high corrosion resistance stainless steel excellent also in economical efficiency.

[0012]

[Means for Solving the Problem] The above-mentioned technical problem is solved by the next invention. A chemical entity is mass% and the invention is C:0.02% or less, below Si:1.0 %, and Mn. : It is the high anticorrosion stainless steel which the remainder is iron substantially and fills the following formula including 2.0% or less, Cr:20-27%, nickel+Co:17-27%, Mo+1/2W:2-7%, N:0.01 - 0.3%, and Cu:0.1-3%.

[0013] The symbol of element in Cr+nickel+Co+2Cu+4.1(Mo+1/2W) +24-N>=62 type shows mass% of each element.

[0014] Either the following ** - ** may be further added at mass% here.

Among less than [Zr:0.5%], B:0.01% or less ** Less than [more than 1 sort ** calcium:0.02%], aluminum: Less than [0.1%], less than [La:0.04%], less than [Ce:0.04%], One or more of less than [more than 1 sort ** Ti:0.5%], less than [Nb:0.8%], less than [Ta:1.6%], and V:1% or less of the sorts of Y:0.1% or less of inside can also add again, combining the above-mentioned **, **, and ** suitably.

[0015] As an ingredient used for the oxidative degradation method by supercritical water, instead of expensive nickel radical alloy, this invention was made, while examining applying the stainless steel of an iron machine. It succeeded in securing the corrosion resistance in oxidative degradation processing, without increasing the addition of nickel sharply, as a result of examining the combination of various alloying elements wholeheartedly.

[0016] Hereafter, the reason for limitation of the chemical entity in this invention is explained.

[0017] C: In order for 0.02%or less C to combine with Cr, to form carbide and to decrease the high-temperature-corrosion-proof disposition top effectiveness of the steel by Cr, few things of the content are desirable. If the amount of C is 0.02% or less, since corrosion resistance degradation is slight, it will make an addition 0.02% or less. [0018] Si: Although below 1.0 % Si is effective as a deoxidizer, if 1.0 % is exceeded, it will accelerate a deposit of an intermetallic compound remarkably and will reduce hot-working nature. Therefore, the addition of Si is made below into 1.0 %.

[0019] Mn: 2.0%or less Mn is a deoxidizer, and in order to raise hot-working nature, 2.0% or less may also be included. Corrosion resistance will be reduced if it exceeds 2.0%. Therefore, the addition of Mn is made into 2.0% or less.

[0020] Cr : Cr has the important work which raises the high-temperature-corrosion-proof nature of steel 20 to 27%. In an elevated-temperature high-pressure oxidation process environment, less than 20% of addition is not enough as the effectiveness. On the other hand, if Cr is added exceeding 27%, a weak intermetallic compound will become easy to deposit and a hot mechanical property and workability will deteriorate. Therefore, the addition of Cr is made into 20 - 27% of within the limits.

[0021] nickel+Co: 17 - 27%nickel enters into the protective film on the front face of steel produced in an elevated temperature, and the corrosion resistance in an elevated-temperature high-pressure oxidation process environment is raised through improving the adhesion of a protective film. About this effectiveness, since it is

equivalent to nickel, Co is totaled and is treated as an addition of nickel+Co. At less than 17%, the corrosion resistance improvement effectiveness does not have the remarkable addition of nickel+Co. On the other hand, it is nickel+Co. Even if it adds exceeding 27%, the effectiveness comes to spoil about [saturate] and economical efficiency. Therefore, the addition of nickel+Co is made into 17 - 27% of within the limits.
[0022] Mo+1/2W : 2 - 7%Mo has the remarkable effectiveness of raising the corrosion resistance of steel materials to the corrosion of a pitting mold. If the effectiveness is not remarkable and is added on the other hand exceeding 7% by addition of less than 2% of Mo, high-temperature-oxidation-proof nature will deteriorate. Moreover, at mass%, since it is equivalent to Mo in the amount of 1/the 2, 1/2W [i.e.,], W is totaled and is treated as an addition of Mo+1/2W. Therefore, the addition of Mo+1/2W is made into 2 - 7% of within the limits.
[0023] While N:0.01 - 0.3%N has the effectiveness of raising the corrosion resistance of the steel materials to the corrosion of a pitting mold, the austenite texture of steel is stabilized and it has the effectiveness which inhibits that a weak intermetallic compound deposits. Although 0.01% or more needs to be added in order to acquire such effectiveness, in addition exceeding 0.3%, steel-manufacture cost goes up and economical efficiency is spoiled. Therefore, the addition of N is made into 0.01 - 0.3% of within the limits.
[0024] Cu : Although Cu raises the acid resistance of steel 0.1 to 3%, if less than 0.1% of addition is not enough as the effectiveness and it adds exceeding 3%, hot-working nature will be degraded. Therefore, the addition of Cu is made into 0.1 - 3% of within the limits. Since this invention makes the above chemical entity a fundamental component and raises various properties further, it can add the following element.
[0025] B, Zr : While of B<=0.01% and Zr<=0.5%, although one or more sort B has effectiveness in improvement in grain boundary reinforcement by little addition, if it adds exceeding 0.01%, it will make the inclination of a welding hot tear remarkable. Therefore, when adding B, it may be 0.01% or less. Although Zr has effectiveness in improvement in grain boundary reinforcement similarly, if it adds exceeding 0.5%, the inclination of a welding hot tear will be made remarkable. Therefore, Zr When adding, it may be 0.5% or less.
[0026] calcium, aluminum, La, Ce, Y : Or more by one of calcium<=0.02%, aluminum<=0.1%, La<=0.04%, Ce<=0.04%, and Y<=0.1% of sorts, by carrying out little addition of the one or more sorts, calcium, aluminum, La, Ce, and Y form a precise oxide film in a front face, or are incorporated in Cr oxide, and raise high-temperature-oxidation-proof nature. However, 0.1%, if it exceeds 0.04% in Ce, it exceeds 0.1% in Y and it adds 0.04%, the hot-working nature of steel will be degraded and it will become easy to generate a surface crack in La by aluminum 0.02% from calcium. Therefore, when adding calcium, aluminum, La, Ce, and Y, one or more of less than [calcium:0.02%], less than [aluminum:0.1%], less than [La:0.04%], less than [Ce:0.04%], and Y:0.1% or less of sorts are chosen, and it adds.
[0027] Ti, Nb, Ta, V : They are Ti, Nb, Ta, and V one or more of Ti<=0.5%, Nb<=0.8%, Ta<=1.6%, and V<=1% of sorts. Corrosion-resistant degradation is reducible by combining with the carbon in steel, forming carbide, and controlling generation of Cr carbide. However, 0.5%, by Nb, when it exceeds 1.6% in Ta, it exceeds 1% in V and it adds 0.8%, a weak intermetallic compound becomes easy to deposit at Ti. Therefore, when adding Ti, Nb, Ta, and V, one or more of less than [Ti:0.5%], less than [Nb:0.8%], less than [Ta:1.6%], and V:1% or less of sorts are chosen, and it adds.
[0028] Limited type of a chemical entity: The corrosion-resistant characteristic R of the following formula (1) can estimate the effect of the chemical entity exerted on the corrosion rate in a Cr+nickel+Co+2Cu+4.1 (Mo+1/2W)+24-N>=62 elevated-temperature high-pressure hydroxylation environment.
[0029]
R = Cr+nickel+Co+2Cu+4.1(Mo+1/2W)+24N (1) Here, the symbol of element shows mass% of each element.
[0030] As the value of a formula (1) shows the corrosion rate of the equipment ingredient in the elevated-temperature high-pressure hydroxylation environment containing a chlorine ion to drawing 1 , it is arranged good. Or more in 62, a corrosion rate becomes less than [0.5 g/m2h], and the value of a formula (1) can secure from this drawing the corrosion-resistant level permitted as the above-mentioned equipment ingredient. With it, fluctuation of a corrosion rate is also converged quickly, and the stable corrosion-resistant ability comes to be shown. As mentioned above, a chemical entity is prescribed that the value of a formula (1) becomes 62 or more. This is Cr+nickel+Co+2Cu+4.1(Mo+1/2W)+24N>=62, when expressed with inequality. It is set to (2).
[0031] In addition, unless an operation and effectiveness of this invention are abolished in these means, saying "the remainder is iron substantially", an unescapable impurity is begun and it means that the thing containing other trace elements is contained in the range of this invention.

[0032]
[Embodiment of the Invention] If in charge of operation of this invention, based on the above-mentioned chemical entity, it can manufacture by the same approach as the usual stainless steel. That is, it rolls out after remaining as it is or cooling, and the cast piece obtained by continuous casting etc. is manufactured as a steel plate or a steel pipe.
[0033] The chemical entity of this invention is based on the examination about the corrosion and practicality of an equipment ingredient in supercritical water and subcritical hydrological environment. The oxidizing quality of the medium in elevated-temperature high-pressure hydrological environment became clear [that possibility that the local corrosion by the hydrochloric acid generated in a decomposition processing process is accelerating ingredient damage from the first is large] through examination.
[0034] First of all, oxidizing power is also considered that the corrosion mechanism near high temperature corrosion, wet corrosion, especially localized corrosion overlaps, and is speeding up ingredient damage in a large environment by the chlorinated system made into the object of this invention. However, improvement in high-temperature-corrosion-proof nature and corrosion-resistant improvement in a localized corrosion environment are conflicting in many respects from a viewpoint of alloy designing, and it is difficult for them to make it compatible.
[0035] Then, the corrosion-resistant improvement technique from a new view was examined wholeheartedly, and the stability of the oxide film produced at the elevated temperature in the process found out being influenced based on the content of not only Cr content said conventionally but nickel. When nickel was moreover contained for the oxide film with Cr oxide subject as a result of examination, it traced that there was an inclination for the adhesion and protection nature to a base material of a coat to improve.
[0036] Consideration of this inclination relates contraction of the coefficient-of-linear-expansion difference of the slight increment in the ductility of the oxide film itself, an oxide, and a base material to improvement in adhesion. Moreover, it is considered that reduction of diffusion rates, such as oxygen in the inside of the nickel-Cr system oxide at the time of comparing with a Fe-Cr system oxide, etc. relates to improvement in protection nature. Though it is conventionally made expensive and is avoided, here is the background which could not but apply nickel radical alloy to the application of an elevated-temperature high-pressure water plant.
[0037] Then, since dissolution of nickel to an oxide film is effective in the resistance to the environment which high temperature corrosion and wet corrosion superimposed, there should just be sufficient amount of nickel to improve the property of a coat. When securing even the minimal dose of such a nickel addition, even if it was the stainless steel of an iron machine, the experiment was continued based on the view that the excellent enough corrosion resistance should be able to demonstrate.
[0038] In the experiment, the alloy of the presentation which the addition of an element besides Cr, nickel, and Fe was changed, and combined it was prepared. Even if it added nickel through examination more than a certain amount, the presentation of an oxide film was saturated and the knowledge that adhesion was saturated was acquired. As an addition, it was shown clearly that it is necessary to make Cr into 20% or more, that addition of nickel of tales doses brings about this and improvement with an almost fast coat property, etc. Furthermore, a certain thing became clear as an element which is useful to improvement in the stability of an oxide film.
[0039] In order to serve as an actual equipment ingredient, it is very important that the workability of an ingredient, ductility, weldability, etc. are excellent. From the viewpoint, the metal texture should set up the alloying element by making ****** used as an austenite texture into an indispensable condition. Moreover, carrying out a materials design in the range of a low alloy as much as possible also needs to mind from consideration for big galvanic corrosion etc. not to occur between the stainless steel and the ferrous materials with which being used on the outskirts so much is expected.
[0040] This invention offers the stainless steel excellent in the corrosion resistance in elevated-temperature high-pressure hydrological environment based on the above view. About a chemical entity, it is good to perform it as follows preferably.
[0041] P: 0.002 - 0.02%P will degrade weldability, if it is an impurity, and it is so good that it is low and a content exceeds 0.02%. However, if it is made to fall to less than 0.002%, the cost of deP processings will increase. Therefore, it is desirable to make P into 0.002 - 0.02% of range.
[0042] S: 0.01%or less S will degrade hot-working nature, if it is an impurity, and it is so good that it is low and a content exceeds 0.01%. Therefore, it is desirable to make S into 0.01% or less.
[0043] N: By adding 0.15 - 0.3%N 0.15% or more preferably, the austenite texture of steel is stabilized and the

deposit suppression effectiveness of a weak intermetallic compound is acquired more certainly.

[0044] As an application gestalt of the high anticorrosion stainless steel of this invention, it is most suitable to use as the structure thru/or the flow conduit for reaction containers of a plant facility. Furthermore, even if it uses as the internal structure of a reaction container, casing of a control unit, etc., suitable corrosion resistance and a suitable mechanical property can be demonstrated.

[0045]

[Example] The stainless steel which has the chemical entity shown in Table 1 was ingoted by the vacuum induction dissolution, it hot-rolled by having carried out soak to 1200 degrees C after casting, and the steel plate of 10mm thickness was manufactured. About the steel plate after hot rolling, the lug crack situation and the generating situation of a surface crack were evaluated. The test piece of 135mmLx5mmwx1mmt was cut down succeedingly, and the corrosion test was presented by surface polish finishing.

[0046]

[Table 1]

	No.	化学成分(mass %) C	Si	Mn	P	S	Cu	Ni	Co	Cr	Mo	W	N	その他	R	腐食速度* g/m²h	熱間加工性
本発明鋼	1	0.006	0.13	0.14	0.008	0.000	0.75	18.0	0.11	20.0	5.5	0.0	0.24		67.92	0.422	○
	2	0.005	0.28	1.60	0.004	0.001	1.51	21.8	0.01	25.0	4.4	0.0	0.22		73.15	0.371	○
	3	0.016	0.24	1.05	0.005	0.000	1.03	17.6	0.01	24.4	4.7	0.0	0.26		69.58	0.401	○
	4	0.007	0.11	0.17	0.007	0.001	0.11	22.1	0.01	21.3	3.0	1.2	0.21		63.43	0.495	○
	5	0.005	0.20	0.79	0.004	0.001	2.81	26.1	0.02	20.3	4.6	0.0	0.19		75.46	0.364	○
	6	0.010	0.22	0.31	0.006	0.000	1.44	25.5	0.02	24.9	4.2	0.0	0.23		76.04	0.368	○
	7	0.008	0.14	0.18	0.008	0.000	1.46	24.3	0.02	26.6	2.1	0.6	0.20		68.48	0.433	○
	8	0.007	0.18	0.15	0.005	0.000	0.82	21.0	0.01	22.5	4.5	0.0	0.21		68.64	0.415	○
	9	0.009	0.23	0.34	0.007	0.001	1.23	21.4	0.01	23.8	6.3	0.8	0.21		80.18	0.319	○
	10	0.007	0.18	1.52	0.004	0.000	1.49	22.3	0.01	24.6	4.6	0.0	0.22	B: 0.004	74.03	0.354	○
	11	0.006	0.17	1.49	0.005	0.000	1.47	22.0	0.01	24.5	4.8	1.0	0.23	Zr: 0.15	76.70	0.331	○
	12	0.008	0.24	1.05	0.005	0.000	1.00	19.2	0.01	24.4	4.3	0.0	0.20	Ca: 0.003	68.04	0.420	○
	13	0.004	0.15	0.19	0.007	0.000	1.29	25.1	0.02	22.2	6.0	0.0	0.22	Al: 0.1	79.78	0.328	○
	14	0.005	0.27	0.12	0.008	0.000	1.45	20.2	0.01	25.1	4.1	0.0	0.22	Ce: 0.03	70.30	0.416	○
	15	0.018	0.25	0.18	0.007	0.001	0.74	18.4	0.00	24.5	4.3	0.0	0.21	Ti: 0.36	67.05	0.427	○
	16	0.014	0.19	0.24	0.006	0.000	1.33	19.9	0.01	21.0	4.4	0.0	0.18	Ta: 1.2	65.93	0.475	○
	17	0.013	0.22	0.22	0.008	0.000	1.32	20.3	0.01	21.9	4.5	0.0	0.21	Ti:0.25,Nb:0.44	68.34	0.426	○
	18	0.012	0.28	0.17	0.004	0.000	1.12	23.1	0.01	23.7	5.7	0.0	0.22	Nb:0.26,V:0.38	77.70	0.326	○
	19	0.015	0.25	0.23	0.006	0.001	1.43	22.8	0.01	23.1	5.0	0.0	0.19	B:0.003,Ti:0.33	73.83	0.373	○
	20	0.007	0.14	1.03	0.008	0.000	0.97	22.6	0.01	25.2	4.4	0.0	0.20	B:0.004, Ca:0.003 La:0.03	72.59	0.392	○

$R = Cr + (Ni + Co + 2Cu) + 4.1(Mo + 1/2\ W) + 24N$

○: 良好

[0047] The corrosion test simulated the reaction container environment of a trichloroethylene decomposition processing plant, dipped it into the pure water which added the trichloroethylene, the sodium hydroxide of equimolar, and the hydrogen peroxide of equimolar 2%, and was performed. Measurement was held by the temperature of 550 degrees C, and pressure 35MPa for 1 hour, measured the amount of corrosion, and it was converted into the thinning rate and it evaluated it. The above evaluation result is also collectively shown in

Table 1.

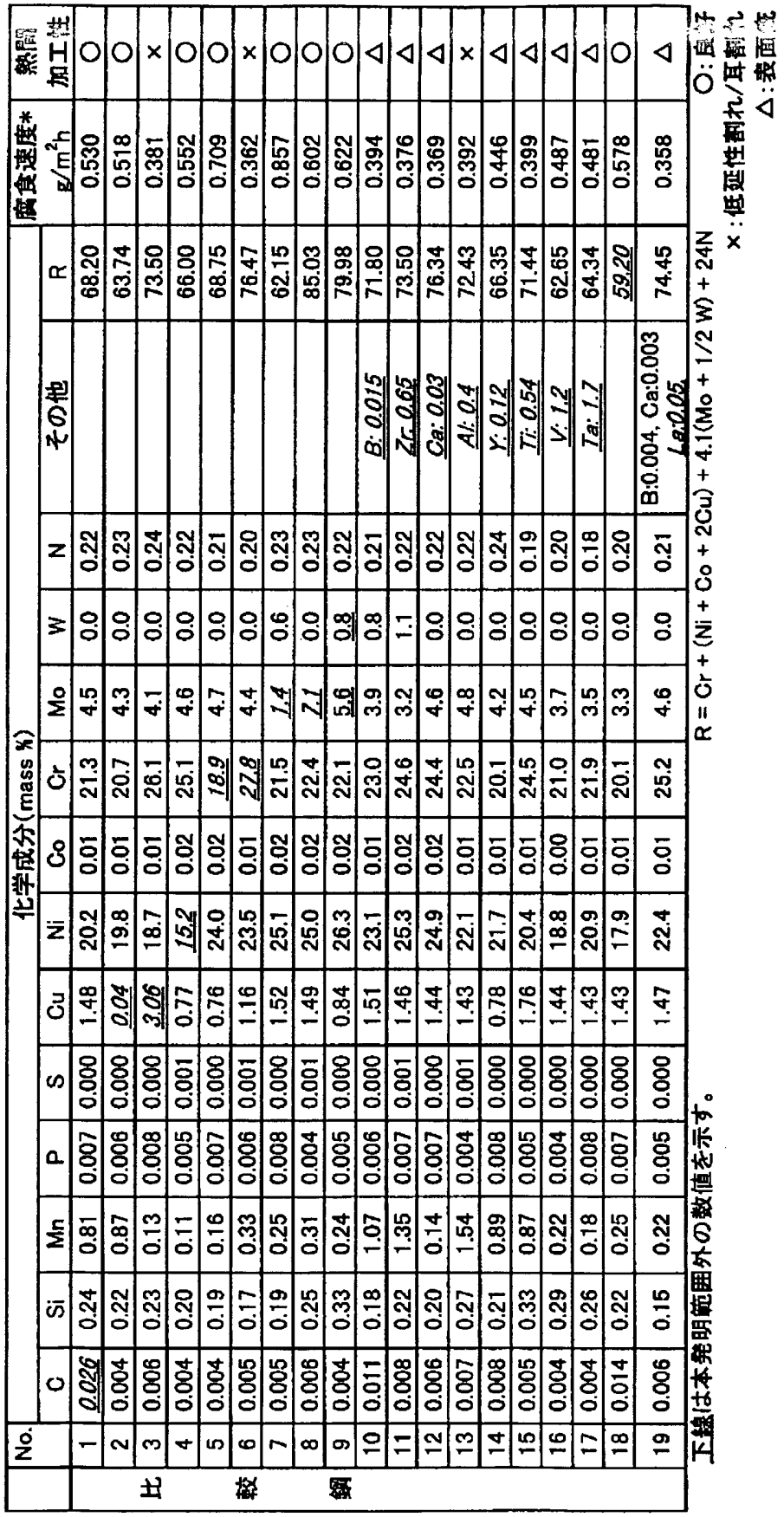
[0048] The hot-working nature of this invention steel does not have generating of a crack or a crack (a table O mark), and has been rolled out good. Moreover, the corrosion rate (a table column of corrosion rate *) of the reaction container simulation environment of a trichloroethylene decomposition processing plant has attained the corrosion rate of under 0.5 g/m2h (=0.55 mm/year) made into a target.

[0049] If the desired value (= 0.55 mm/year) of this corrosion rate is maintainable, an equipment life will be assumed to be ten years and it will be estimated as 11mm as need board thickness for thinning to stop at an equivalent for 1 / 2 thickness. This adjusts the thickness (10-15mm) of the reaction container currently assumed in the industrial processing plant of 1 ton/day, and it is economical and it turns out that the limit design about a property is realizable.

[0050] About the comparison steel with which a chemical entity does not go into the range of this invention, evaluation and corrosion resistance evaluation of a lug crack and a surface crack were similarly carried out through the process of vacuum melting, casting, and hot rolling. The chemical entity and evaluation result of comparison steel are collectively shown in Table 2.

[0051]

[Table 2]



	No.	化学成分(mass %) C	Si	Mn	P	S	Cu	Ni	Co	Cr	Mo	W	N	その他	R	腐食速度* g/m²h	熱間加工性
比較鋼	1	*0.026*	0.24	0.81	0.007	0.000	1.48	20.2	0.01	21.3	4.5	0.0	0.22		68.20	0.530	○
	2	0.004	0.22	0.87	0.006	0.000	*0.04*	19.8	0.01	20.7	4.3	0.0	0.23		63.74	0.518	○
	3	0.006	0.23	0.13	0.008	0.000	*3.06*	18.7	0.01	26.1	4.1	0.0	0.24		73.50	0.381	×
	4	0.004	0.20	0.11	0.005	0.001	0.77	*15.2*	0.02	25.1	4.6	0.0	0.22		66.00	0.552	○
	5	0.004	0.19	0.16	0.007	0.000	0.76	24.0	0.02	*18.9*	4.7	0.0	0.21		68.75	0.709	○
	6	0.005	0.17	0.33	0.006	0.001	1.16	23.5	0.01	*27.8*	4.4	0.0	0.20		76.47	0.362	×
	7	0.005	0.19	0.25	0.008	0.000	1.52	25.1	0.02	21.5	*1.4*	0.6	0.23		62.15	0.857	○
	8	0.006	0.25	0.31	0.004	0.001	1.49	25.0	0.02	22.4	*7.1*	0.0	0.23		85.03	0.602	○
	9	0.004	0.33	0.24	0.005	0.000	0.84	26.3	0.02	22.1	5.6	0.8	0.22		79.98	0.622	○
	10	0.011	0.18	1.07	0.006	0.000	1.51	23.1	0.01	23.0	3.9	0.8	0.21	*B: 0.015*	71.80	0.394	△
	11	0.008	0.22	1.35	0.007	0.001	1.46	25.3	0.02	24.6	3.2	1.1	0.22	*Zr: 0.65*	73.50	0.376	△
	12	0.006	0.20	0.14	0.007	0.000	1.44	24.9	0.02	24.4	4.6	0.0	0.22	*Ca: 0.03*	76.34	0.369	△
	13	0.007	0.27	1.54	0.004	0.001	1.43	22.1	0.01	22.5	4.8	0.0	0.22	*Al: 0.4*	72.43	0.392	×
	14	0.008	0.21	0.89	0.008	0.000	0.78	21.7	0.01	20.1	4.2	0.0	0.24	*Y: 0.12*	66.35	0.446	△
	15	0.005	0.33	0.87	0.005	0.000	1.76	20.4	0.01	24.5	4.5	0.0	0.19	*Ti: 0.54*	71.44	0.399	△
	16	0.004	0.29	0.22	0.004	0.000	1.44	18.8	0.00	21.0	3.7	0.0	0.20	*V: 1.2*	62.65	0.487	△
	17	0.004	0.26	0.18	0.008	0.000	1.43	20.9	0.01	21.9	3.5	0.0	0.18	*Ta: 1.7*	64.34	0.481	△
	18	0.014	0.22	0.25	0.007	0.000	1.43	17.9	0.01	20.1	3.3	0.0	0.20		*59.20*	0.578	○
	19	0.006	0.15	0.22	0.005	0.000	1.47	22.4	0.01	25.2	4.6	0.0	0.21	B:0.004, Ca:0.003 *La:2.05*	74.45	0.358	△

下線は本発明範囲外の数値を示す。

R = Cr + (Ni + Co + 2Cu) + 4.1(Mo + 1/2 W) + 24N

○:良好

×:低延性割れ/耳割れ

△:表面疵

[0052] It is divided, there are some which the surface crack generated, and the hot-working nature of comparison steel is shown in a table by x mark and ** mark. The low ductility crack in the elevated temperature considered that what the crack generated (x mark) relates to a deposit of an intermetallic compound, or the lug

crack considered to originate in lack of grain boundary reinforcement occurs. It is thought that what the surface crack generated (** mark) is depended on the same cause. About the corrosion resistance of comparison steel, there is also a thing exceeding above-mentioned desired value 2 h of 0.5g/m of a corrosion rate.

[0053] Thus, in the invention steel shown in Table 1, hot-working nature and corrosion resistance both sides are good about all examples by the suitable combination of an alloying element. On the other hand, in the comparison steel shown in Table 2, difficulty is in hot-working nature or corrosion resistance either, and both sides cannot be reconciled. As mentioned above, it turns out to the application of this invention that a convention of this invention is effective.

[0054]

[Effect of the Invention] The high anticorrosion stainless steel of this invention can be applied to supercritical water and a subcritical hydroxylation plant by preparing a chemical entity appropriately. Consequently, when it applies to the internal structure of the structure for reaction containers, a flow conduit, and a reaction container etc., good corrosion resistance and a good mechanical property can be demonstrated, and, moreover, the failure of economical efficiency can be conquered. Thus, while a prospect is acquired by equipment manufacture of the SCWO (supercritical hydroxylation) processing plant of industrial hazardous wastes and very useful effectiveness is acquired on industry, it can contribute to the creation of an environmental related industry.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the equipment ingredient of the elevated-temperature high-pressure fluid use technical relation in the supercritical water, the subcritical hydroxylation plant, etc. which noxious waste can also process.

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PRIOR ART

[Description of the Prior Art] While the interest about environmental preservation increases in whole company meeting, a close-up of processing of the toxic material of the difficulty resolvability represented by the chlorinated system organic compound is taken as a future big problem. The oxidation-treatment technique using an elevated-temperature high-pressure fluid is observed as a technique used as the conclusive factor of these decomposition processings these days.

[0003] If the matter exceeds predetermined temperature and flow and pressure requirement, it will be in the supercritical fluid condition with which the liquid and the gas harmonized completely, and the chemical reaction of the matter will be provided with a very activity reaction place also including the subcritical fluid condition of this side. In such a condition, although the application to the waste treatment in supercritical and a subcritical condition is variously tried very much as stability and safe matter and water is used present most widely as a medium of the oxidative degradation of a harmful organic compound, the number of it is one.

[0004] The oxidative degradation method by supercritical water has left the technical problem to the corrosion resistance of an ingredient practical, although the fundamental technique itself is in the situation established mostly. That is, the equipment ingredient itself which touches the chemical reaction place which has very high reactivity has received corrosion damage violently in the present condition.

[0005] Then, nickel radical alloy of high corrosion resistance is mainly used. Moreover, ceramics ingredients, such as a titanic-acid ghost and charcoal and a nitride, a zirconium, and aluminum oxide, are also examined in part from generally corrosion resistance being good.

[0006] In addition, austenitic heat resisting steel has been used for the boiler for which creep strength, a waterproof steamy oxidization property, and high-temperature-corrosion-proof nature are generally needed. An operating environment is making especially a boiler cruel and the austenite heat-resistant alloy is developed for the purpose of sufficient corrosion resistance and the outstanding high temperature strength.

[0007] For example, in JP,6-322488,A, it is less than C:0.02% and less than [Si:1.5%] (an example 0.47 - 0.50%) at mass %, Mn: 0.3-1.5%, P:0.02% or less, S:0.005% or less, Cr: 18-26%, nickel:20-40%, W:0.5 - 10.0%, Nb: 0.05-0.4% (an example 0.18 - 0.23%), Ti:0.01-0.2%, B:0.003 - 0.008% and N:0.05 - 0.3% (an example 0.008 - 0.147%) are contained. Furthermore, the austenite heat-resistant alloy containing two of one sort or Mo:0.5-2.0% and/or Mg:0.001-0.05%, calcium:0.001-0.05%, and rare-earth-elements:0.001-0.15% of sorts or more is proposed if needed.

[0008] In JP,2000-129403,A, it is C:0.01 - 0.20% (preferably 0.035 - 0.15%), Si: Less than [3.0%] (preferably 0.5 - 2.0%), Mn:0.01-3.0% and nickel:15.0-40.0%, Less than [Ti:0.2%], B:0.006% or less, and N:0.05 - 0.25% (preferably 0.07 - 0.02%) are contained Cr:15.0-30.0%, Mo:0.01-1.0%, W:2.0 - 8.0%, and Nb:0.05-0.8%. The superheater tube for boilers using that W/Mo has 2 or more and 20 - 55% of Fe(s), and the austenite heat-resistant alloy and it which contain one or more sorts of 0.01 - 0.5% of Ta, 0.001 - 0.2% of Zr, and 0.001 - 0.2% of Hf(s) further is proposed.

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EFFECT OF THE INVENTION

[Effect of the Invention] The high anticorrosion stainless steel of this invention can be applied to supercritical water and a subcritical hydroxylation plant by preparing a chemical entity appropriately. Consequently, when it applies to the internal structure of the structure for reaction containers, a flow conduit, and a reaction container etc., good corrosion resistance and a good mechanical property can be demonstrated, and, moreover, the failure of economical efficiency can be conquered. Thus, while a prospect is acquired by equipment manufacture of the SCWO (supercritical hydroxylation) processing plant of industrial hazardous wastes and very useful effectiveness is acquired on industry, it can contribute to the creation of an environmental related industry.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there are the following troubles in these ingredients. First, about nickel radical alloy, when an expensive and large-scale practical use plant is assumed, ingredient cost will become huge and is holding the big technical problem in the balance of cost effectiveness with waste treatment etc. The present condition is that breakage by the thermal shock generally tends to take place, and a ceramics ingredient lacks in practical dependability.
[0010] From a viewpoint of dependability over a thermal shock etc., using the austenitic heat resisting steel for the above-mentioned boilers is also considered. However, these ingredients Since the component design which mainly aimed at the endurance to a high-temperature-corrosion environment is made, in the oxidation and corrosive environment to which supercritical water and subcritical water change, it has a problem in the corrosion resistance in the conditions on which wet corrosion mainly governs corrosion. That is, the consideration to the optimization of element addition, such as Cu and Mo, a technique given in JP,6-322488,A and whose technique given in JP,2000-129403,A can improve the corrosion resistance over wet corrosion is not made enough, or is not added at all. That is, it is a problem from a viewpoint of the general corrosion in a wet corrosion region.
[0011] the high dependability to the corrosion resistance and the mechanical property which were excellent as an equipment ingredient in the oxidative degradation processing plant of the noxious waste which this invention solved the above-mentioned technical problem, and used the elevated-temperature high-pressure fluid etc. -- having -- in addition -- and it aims at offering the high corrosion resistance stainless steel excellent also in economical efficiency.

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MEANS

[Means for Solving the Problem] The above-mentioned technical problem is solved by the next invention. A chemical entity is mass% and the invention is C:0.02% or less, below Si:1.0 %, and Mn. : It is the high anticorrosion stainless steel which the remainder is iron substantially and fills the following formula including 2.0% or less, Cr:20-27%, nickel+Co:17-27%, Mo+1/2W:2-7%, N:0.01 - 0.3%, and Cu:0.1-3%.
[0013] The symbol of element in Cr+nickel+Co+2Cu+4.1(Mo+1/2W) +24-N>=62 type shows mass% of each element.
[0014] Either the following ** - ** may be further added at mass% here.
Among less than [Zr:0.5%], B:0.01% or less ** Less than [more than 1 sort ** calcium:0.02%], aluminum: Less than [0.1%], less than [La:0.04%], less than [Ce:0.04%], One or more of less than [more than 1 sort ** Ti:0.5%], less than [Nb:0.8%], less than [Ta:1.6%], and V:1% or less of the sorts of Y:0.1% or less of inside can also add again, combining the above-mentioned **, **, and ** suitably.
[0015] As an ingredient used for the oxidative degradation method by supercritical water, instead of expensive nickel radical alloy, this invention was made, while examining applying the stainless steel of an iron machine. It succeeded in securing the corrosion resistance in oxidative degradation processing, without increasing the addition of nickel sharply, as a result of examining the combination of various alloying elements wholeheartedly.
[0016] Hereafter, the reason for limitation of the chemical entity in this invention is explained.
[0017] C: In order for 0.02%or less C to combine with Cr, to form carbide and to decrease the high-temperature-corrosion-proof disposition top effectiveness of the steel by Cr, few things of the content are desirable. If the amount of C is 0.02% or less, since corrosion resistance degradation is slight, it will make an addition 0.02% or less. [0018] Si: Although below 1.0 % Si is effective as a deoxidizer, if 1.0 % is exceeded, it will accelerate a deposit of an intermetallic compound remarkably and will reduce hot-working nature. Therefore, the addition of Si is made below into 1.0 %.
[0019] Mn: 2.0%or less Mn is a deoxidizer, and in order to raise hot-working nature, 2.0% or less may also be included. Corrosion resistance will be reduced if it exceeds 2.0%. Therefore, the addition of Mn is made into 2.0% or less.
[0020] Cr : Cr has the important work which raises the high-temperature-corrosion-proof nature of steel 20 to 27%. In an elevated-temperature high-pressure oxidation process environment, less than 20% of addition is not enough as the effectiveness. On the other hand, if Cr is added exceeding 27%, a weak intermetallic compound will become easy to deposit and a hot mechanical property and workability will deteriorate. Therefore, the addition of Cr is made into 20 - 27% of within the limits.
[0021] nickel+Co: 17 - 27%nickel enters into the protective film on the front face of steel produced in an elevated temperature, and the corrosion resistance in an elevated-temperature high-pressure oxidation process environment is raised through improving the adhesion of a protective film. About this effectiveness, since it is equivalent to nickel, Co is totaled and is treated as an addition of nickel+Co. At less than 17%, the corrosion resistance improvement effectiveness does not have the remarkable addition of nickel+Co. On the other hand, it is nickel+Co. Even if it adds exceeding 27%, the effectiveness comes to spoil about [saturate] and economical efficiency. Therefore, the addition of nickel+Co is made into 17 - 27% of within the limits.
[0022] Mo+1/2W : 2 - 7%Mo has the remarkable effectiveness of raising the corrosion resistance of steel materials to the corrosion of a pitting mold. If the effectiveness is not remarkable and is added on the other hand exceeding 7% by addition of less than 2% of Mo, high-temperature-oxidation-proof nature will deteriorate. Moreover, at mass%, since it is equivalent to Mo in the amount of 1/the 2, 1/2W [i.e.,], W is totaled and is

treated as an addition of Mo+1/2W. Therefore, the addition of Mo+1/2W is made into 2 - 7% of within the limits.

[0023] While N:0.01 - 0.3%N has the effectiveness of raising the corrosion resistance of the steel materials to the corrosion of a pitting mold, the austenite texture of steel is stabilized and it has the effectiveness which inhibits that a weak intermetallic compound deposits. Although 0.01% or more needs to be added in order to acquire such effectiveness, in addition exceeding 0.3%, steel-manufacture cost goes up and economical efficiency is spoiled. Therefore, the addition of N is made into 0.01 - 0.3% of within the limits.

[0024] Cu : Although Cu raises the acid resistance of steel 0.1 to 3%, if less than 0.1% of addition is not enough as the effectiveness and it adds exceeding 3%, hot-working nature will be degraded. Therefore, the addition of Cu is made into 0.1 - 3% of within the limits. Since this invention makes the above chemical entity a fundamental component and raises various properties further, it can add the following element.

[0025] B, Zr : While of B<=0.01% and Zr<=0.5%, although one or more sort B has effectiveness in improvement in grain boundary reinforcement by little addition, if it adds exceeding 0.01%, it will make the inclination of a welding hot tear remarkable. Therefore, when adding B, it may be 0.01% or less. Although Zr has effectiveness in improvement in grain boundary reinforcement similarly, if it adds exceeding 0.5%, the inclination of a welding hot tear will be made remarkable. Therefore, Zr When adding, it may be 0.5% or less.

[0026] calcium, aluminum, La, Ce, Y : Or more by one of calcium<=0.02%, aluminum<=0.1%, La<=0.04%, Ce<=0.04%, and Y<=0.1% of sorts, by carrying out little addition of the one or more sorts, calcium, aluminum, La, Ce, and Y form a precise oxide film in a front face, or are incorporated in Cr oxide, and raise high-temperature-oxidation-proof nature. However, 0.1%, if it exceeds 0.04% in Ce, it exceeds 0.1% in Y and it adds 0.04%, the hot-working nature of steel will be degraded and it will become easy to generate a surface crack in La by aluminum 0.02% from calcium. Therefore, when adding calcium, aluminum, La, Ce, and Y, one or more of less than [calcium:0.02%], less than [aluminum:0.1%], less than [La:0.04%], less than [Ce:0.04%], and Y:0.1% or less of sorts are chosen, and it adds.

[0027] Ti, Nb, Ta, V : They are Ti, Nb, Ta, and V one or more of Ti<=0.5%, Nb<=0.8%, Ta<=1.6%, and V<=1% of sorts. Corrosion-resistant degradation is reducible by combining with the carbon in steel, forming carbide, and controlling generation of Cr carbide. However, 0.5%, by Nb, when it exceeds 1.6% in Ta, it exceeds 1% in V and it adds 0.8%, a weak intermetallic compound becomes easy to deposit at Ti. Therefore, when adding Ti, Nb, Ta, and V, one or more of less than [Ti:0.5%], less than [Nb:0.8%], less than [Ta:1.6%], and V:1% or less of sorts are chosen, and it adds.

[0028] Limited type of a chemical entity: The corrosion-resistant characteristic R of the following formula (1) can estimate the effect of the chemical entity exerted on the corrosion rate in a Cr+nickel+Co+2Cu+4.1 (Mo+1/2W)+24-N>=62 elevated-temperature high-pressure hydroxylation environment.

[0029]

R = Cr+nickel+Co+2Cu+4.1(Mo+1/2W)+24N (1) Here, the symbol of element shows mass% of each element.

[0030] As the value of a formula (1) shows the corrosion rate of the equipment ingredient in the elevated-temperature high-pressure hydroxylation environment containing a chlorine ion to drawing 1 , it is arranged good. Or more in 62, a corrosion rate becomes less than [0.5 g/m2h], and the value of a formula (1) can secure from this drawing the corrosion-resistant level permitted as the above-mentioned equipment ingredient. With it, fluctuation of a corrosion rate is also converged quickly, and the stable corrosion-resistant ability comes to be shown. As mentioned above, a chemical entity is prescribed that the value of a formula (1) becomes 62 or more. This is Cr+nickel+Co+2Cu+4.1(Mo+1/2W)+24N>=62, when expressed with inequality. It is set to (2).

[0031] In addition, unless an operation and effectiveness of this invention are abolished in these means, saying "the remainder is iron substantially", an unescapable impurity is begun and it means that the thing containing other trace elements is contained in the range of this invention.

[0032]

[Embodiment of the Invention] If in charge of operation of this invention, based on the above-mentioned chemical entity, it can manufacture by the same approach as the usual stainless steel. That is, it rolls out after remaining as it is or cooling, and the cast piece obtained by continuous casting etc. is manufactured as a steel plate or a steel pipe.

[0033] The chemical entity of this invention is based on the examination about the corrosion and practicality of an equipment ingredient in supercritical water and subcritical hydrological environment. The oxidizing quality of the medium in elevated-temperature high-pressure hydrological environment became clear [that possibility

that the local corrosion by the hydrochloric acid generated in a decomposition processing process is accelerating ingredient damage from the first is large] through examination.

[0034] First of all, oxidizing power is also considered that the corrosion mechanism near high temperature corrosion, wet corrosion, especially localized corrosion overlaps, and is speeding up ingredient damage in a large environment by the chlorinated system made into the object of this invention. However, improvement in high-temperature-corrosion-proof nature and corrosion-resistant improvement in a localized corrosion environment are conflicting in many respects from a viewpoint of alloy designing, and it is difficult for them to make it compatible.

[0035] Then, the corrosion-resistant improvement technique from a new view was examined wholeheartedly, and the stability of the oxide film produced at the elevated temperature in the process found out being influenced based on the content of not only Cr content said conventionally but nickel. When nickel was moreover contained for the oxide film with Cr oxide subject as a result of examination, it traced that there was an inclination for the adhesion and protection nature to a base material of a coat to improve.

[0036] Consideration of this inclination relates contraction of the coefficient-of-linear-expansion difference of the slight increment in the ductility of the oxide film itself, an oxide, and a base material to improvement in adhesion. Moreover, it is considered that reduction of diffusion rates, such as oxygen in the inside of the nickel-Cr system oxide at the time of comparing with a Fe-Cr system oxide, etc. relates to improvement in protection nature. Though it is conventionally made expensive and is avoided, here is the background which could not but apply nickel radical alloy to the application of an elevated-temperature high-pressure water plant.

[0037] Then, since dissolution of nickel to an oxide film is effective in the resistance to the environment which high temperature corrosion and wet corrosion superimposed, there should just be sufficient amount of nickel to improve the property of a coat. When securing even the minimal dose of such a nickel addition, even if it was the stainless steel of an iron machine, the experiment was continued based on the view that the excellent enough corrosion resistance should be able to demonstrate.

[0038] In the experiment, the alloy of the presentation which the addition of an element besides Cr, nickel, and Fe was changed, and combined it was prepared. Even if it added nickel through examination more than a certain amount, the presentation of an oxide film was saturated and the knowledge that adhesion was saturated was acquired. As an addition, it was shown clearly that it is necessary to make Cr into 20% or more, that addition of nickel of tales doses brings about this and improvement with an almost fast coat property, etc. Furthermore, a certain thing became clear as an element which is useful to improvement in the stability of an oxide film.

[0039] In order to serve as an actual equipment ingredient, it is very important that the workability of an ingredient, ductility, weldability, etc. are excellent. From the viewpoint, the metal texture should set up the alloying element by making ****** used as an austenite texture into an indispensable condition. Moreover, carrying out a materials design in the range of a low alloy as much as possible also needs to mind from consideration for big galvanic corrosion etc. not to occur between the stainless steel and the ferrous materials with which being used on the outskirts so much is expected.

[0040] This invention offers the stainless steel excellent in the corrosion resistance in elevated-temperature high-pressure hydrological environment based on the above view. About a chemical entity, it is good to perform it as follows preferably.

[0041] P: 0.002 - 0.02%P will degrade weldability, if it is an impurity, and it is so good that it is low and a content exceeds 0.02%. However, if it is made to fall to less than 0.002%, the cost of deP processings will increase. Therefore, it is desirable to make P into 0.002 - 0.02% of range.

[0042] S: 0.01%or less S will degrade hot-working nature, if it is an impurity, and it is so good that it is low and a content exceeds 0.01%. Therefore, it is desirable to make S into 0.01% or less.

[0043] N: By adding 0.15 - 0.3%N 0.15% or more preferably, the austenite texture of steel is stabilized and the deposit suppression effectiveness of a weak intermetallic compound is acquired more certainly.

[0044] As an application gestalt of the high anticorrosion stainless steel of this invention, it is most suitable to use as the structure thru/or the flow conduit for reaction containers of a plant facility. Furthermore, even if it uses as the internal structure of a reaction container, casing of a control unit, etc., suitable corrosion resistance and a suitable mechanical property can be demonstrated.

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EXAMPLE

[Example] The stainless steel which has the chemical entity shown in Table 1 was ingoted by the vacuum induction dissolution, it hot-rolled by having carried out soak to 1200 degrees C after casting, and the steel plate of 10mm thickness was manufactured. About the steel plate after hot rolling, the lug crack situation and the generating situation of a surface crack were evaluated. The test piece of 135mmLx5mmwx1mmt was cut down succeedingly, and the corrosion test was presented by surface polish finishing.
[0046]
[Table 1]

	No.	化学成分(mass %)															腐食速度*	熱間
		C	Si	Mn	P	S	Cu	Ni	Co	Cr	Mo	W	N	その他	R	g/m²h	加工性
本発明鋼	1	0.006	0.13	0.14	0.008	0.000	0.75	18.0	0.11	20.0	5.5	0.0	0.24		67.92	0.422	○
	2	0.005	0.28	1.60	0.004	0.001	1.51	21.8	0.01	25.0	4.4	0.0	0.22		73.15	0.371	○
	3	0.016	0.24	1.05	0.005	0.000	1.03	17.6	0.01	24.4	4.7	0.0	0.26		69.58	0.401	○
	4	0.007	0.11	0.17	0.007	0.001	0.11	22.1	0.01	21.3	3.0	1.2	0.21		63.43	0.495	○
	5	0.005	0.20	0.79	0.004	0.001	2.81	26.1	0.02	20.3	4.6	0.0	0.19		75.46	0.364	○
	6	0.010	0.22	0.31	0.006	0.000	1.44	25.5	0.02	24.9	4.2	0.0	0.23		76.04	0.368	○
	7	0.008	0.14	0.18	0.008	0.000	1.46	24.3	0.02	26.6	2.1	0.6	0.20		68.48	0.433	○
	8	0.007	0.18	0.15	0.005	0.000	0.82	21.0	0.01	22.5	4.5	0.0	0.21		68.64	0.415	○
	9	0.009	0.23	0.34	0.007	0.001	1.23	21.4	0.01	23.8	6.3	0.8	0.21		80.18	0.319	○
	10	0.007	0.18	1.52	0.004	0.000	1.49	22.3	0.01	24.6	4.6	0.0	0.22	B: 0.004	74.03	0.354	○
	11	0.006	0.17	1.49	0.005	0.000	1.47	22.0	0.01	24.5	4.8	1.0	0.23	Zr: 0.15	76.70	0.331	○
	12	0.008	0.24	1.05	0.005	0.000	1.00	19.2	0.01	24.4	4.3	0.0	0.20	Ca: 0.003	68.04	0.420	○
	13	0.004	0.15	0.19	0.007	0.000	1.29	25.1	0.02	22.2	6.0	0.0	0.22	Al: 0.1	79.78	0.328	○
	14	0.005	0.27	0.12	0.008	0.000	1.45	20.2	0.01	25.1	4.1	0.0	0.22	Ce: 0.03	70.30	0.416	○
	15	0.018	0.25	0.18	0.007	0.001	0.74	18.4	0.00	24.5	4.3	0.0	0.21	Ti: 0.36	67.05	0.427	○
	16	0.014	0.19	0.24	0.006	0.000	1.33	19.9	0.01	21.0	4.4	0.0	0.18	Ta: 1.2	65.93	0.475	○
	17	0.013	0.22	0.22	0.008	0.000	1.32	20.3	0.01	21.9	4.5	0.0	0.21	Ti:0.25,Nb:0.44	68.34	0.426	○
	18	0.012	0.28	0.17	0.004	0.000	1.12	23.1	0.01	23.7	5.7	0.0	0.22	Nb:0.26,V:0.38	77.70	0.326	○
	19	0.015	0.25	0.23	0.006	0.001	1.43	22.8	0.01	23.1	5.0	0.0	0.19	B:0.003,Ti:0.33	73.83	0.373	○
	20	0.007	0.14	1.03	0.008	0.000	0.97	22.8	0.01	25.2	4.4	0.0	0.20	B:0.004, Ca:0.003 La:0.03	72.59	0.392	○

R = Cr + (Ni + Co + 2Cu) + 4.1(Mo + 1/2 W) + 24N

○: 良好

[0047] The corrosion test simulated the reaction container environment of a trichloroethylene decomposition processing plant, dipped it into the pure water which added the trichloroethylene, the sodium hydroxide of equimolar, and the hydrogen peroxide of equimolar 2%, and was performed. Measurement was held by the temperature of 550 degrees C, and pressure 35MPa for 1 hour, measured the amount of corrosion, and it was converted into the thinning rate and it evaluated it. The above evaluation result is also collectively shown in

Table 1.

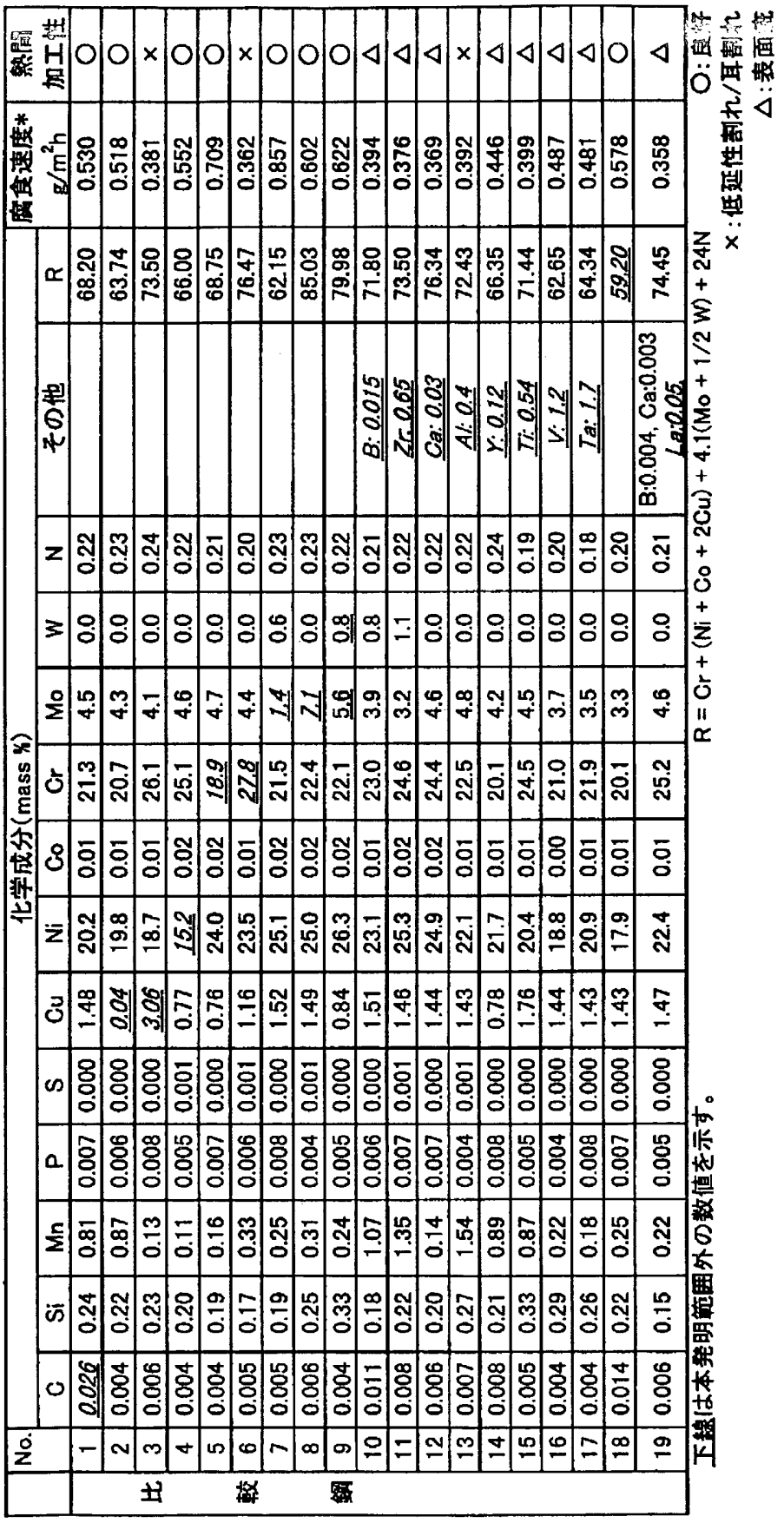
[0048] The hot-working nature of this invention steel does not have generating of a crack or a crack (a table O mark), and has been rolled out good. Moreover, the corrosion rate (a table column of corrosion rate *) of the reaction container simulation environment of a trichloroethylene decomposition processing plant has attained the corrosion rate of under 0.5 g/m2h (=0.55 mm/year) made into a target.

[0049] If the desired value (= 0.55 mm/year) of this corrosion rate is maintainable, an equipment life will be assumed to be ten years and it will be estimated as 11mm as need board thickness for thinning to stop at an equivalent for 1 / 2 thickness. This adjusts the thickness (10-15mm) of the reaction container currently assumed in the industrial processing plant of 1 ton/day, and it is economical and it turns out that the limit design about a property is realizable.

[0050] About the comparison steel with which a chemical entity does not go into the range of this invention, evaluation and corrosion resistance evaluation of a lug crack and a surface crack were similarly carried out through the process of vacuum melting, casting, and hot rolling. The chemical entity and evaluation result of comparison steel are collectively shown in Table 2.

[0051]

[Table 2]



	No.	化学成分(mass %) C	Si	Mn	P	S	Cu	Ni	Co	Cr	Mo	W	N	その他	R	腐食速度* g/m²h	熱間加工性
比較鋼	1	*0.026*	0.24	0.81	0.007	0.000	1.48	20.2	0.01	21.3	4.5	0.0	0.22		68.20	0.530	○
	2	0.004	0.22	0.87	0.006	0.000	*0.04*	19.8	0.01	20.7	4.3	0.0	0.23		63.74	0.518	○
	3	0.006	0.23	0.13	0.008	0.000	*3.06*	18.7	0.01	26.1	4.1	0.0	0.24		73.50	0.381	×
	4	0.004	0.20	0.11	0.005	0.001	0.77	*15.2*	0.02	25.1	4.6	0.0	0.22		66.00	0.552	○
	5	0.004	0.19	0.16	0.007	0.000	0.76	24.0	0.02	*18.9*	4.7	0.0	0.21		68.75	0.709	○
	6	0.005	0.17	0.33	0.006	0.001	1.16	23.5	0.01	*27.8*	4.4	0.0	0.20		76.47	0.362	×
	7	0.005	0.19	0.25	0.008	0.000	1.52	25.1	0.02	21.5	*1.4*	0.6	0.23		62.15	0.857	○
	8	0.006	0.25	0.31	0.004	0.001	1.49	25.0	0.02	22.4	*7.1*	0.0	0.23		85.03	0.602	○
	9	0.004	0.33	0.24	0.005	0.000	0.84	26.3	0.02	22.1	5.6	0.8	0.22		79.98	0.622	○
	10	0.011	0.18	1.07	0.006	0.000	1.51	23.1	0.01	23.0	3.9	0.8	0.21	*B: 0.015*	71.80	0.394	△
	11	0.008	0.22	1.35	0.007	0.001	1.46	25.3	0.02	24.6	3.2	1.1	0.22	*Zr: 0.65*	73.50	0.376	△
	12	0.006	0.20	0.14	0.007	0.000	1.44	24.9	0.02	24.4	4.6	0.0	0.22	*Ca: 0.03*	76.34	0.369	△
	13	0.007	0.27	1.54	0.004	0.001	1.43	22.1	0.01	22.5	4.8	0.0	0.22	*Al: 0.4*	72.43	0.392	×
	14	0.008	0.21	0.89	0.008	0.000	0.78	21.7	0.01	20.1	4.2	0.0	0.24	*Y: 0.12*	66.35	0.446	△
	15	0.005	0.33	0.87	0.005	0.000	1.76	20.4	0.01	24.5	4.5	0.0	0.19	*Ti: 0.54*	71.44	0.399	△
	16	0.004	0.29	0.22	0.004	0.000	1.44	18.8	0.00	21.0	3.7	0.0	0.20	*V: 1.2*	62.65	0.487	△
	17	0.004	0.26	0.18	0.008	0.000	1.43	20.9	0.01	21.9	3.5	0.0	0.18	*Ta: 1.7*	64.34	0.481	△
	18	0.014	0.22	0.25	0.007	0.000	1.43	17.9	0.01	20.1	3.3	0.0	0.20		*59.20*	0.578	○
	19	0.006	0.15	0.22	0.005	0.000	1.47	22.4	0.01	25.2	4.6	0.0	0.21	B:0.004, Ca:0.003 *La:0.05*	74.45	0.358	△

下線は本発明範囲外の数値を示す。

R = Cr + (Ni + Co + 2Cu) + 4.1(Mo + 1/2 W) + 24N

○:良好
×:低延性割れ/耳割れ
△:表面割

[0052] It is divided, there are some which the surface crack generated, and the hot-working nature of comparison steel is shown in a table by x mark and ** mark. The low ductility crack in the elevated temperature considered that what the crack generated (x mark) relates to a deposit of an intermetallic compound, or the lug

crack considered to originate in lack of grain boundary reinforcement occurs. It is thought that what the surface crack generated (** mark) is depended on the same cause. About the corrosion resistance of comparison steel, there is also a thing exceeding above-mentioned desired value 2 h of 0.5g/m of a corrosion rate.

[0053] Thus, in the invention steel shown in Table 1, hot-working nature and corrosion resistance both sides are good about all examples by the suitable combination of an alloying element. On the other hand, in the comparison steel shown in Table 2, difficulty is in hot-working nature or corrosion resistance either, and both sides cannot be reconciled. As mentioned above, it turns out to the application of this invention that a convention of this invention is effective.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the relation between the corrosion-resistant characteristic R and the corrosion rate in an elevated-temperature high-pressure hydroxylation environment.

[Translation done.]

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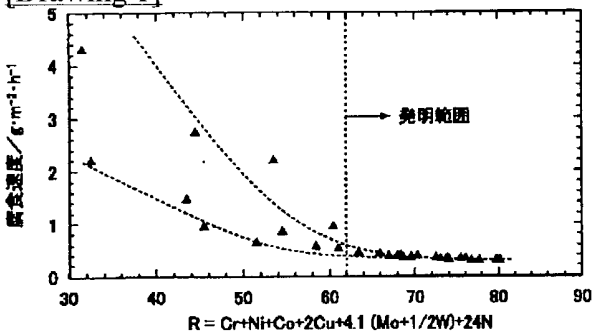
DRAWINGS

[Drawing 1]



[Translation done.]